A Beam of Possibility

~Applications of the Plasma Window

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In a world where airbuses, sky tower cities, quantum computers, and flying cars are destined to rule, there has emerged a gadget – an electron beam propagated by a chamber of plasma- that is full of untamed possibility. Although its predecessor was rather cumbersome, the plasma window can transform the weaknesses of something potentially useful to something that will see its potential unfold in the next century. As a welding device its applications are limitless, and how it welds is just as remarkable.

The humble origins of the plasma window stem from the innate usefulness of welding with electron beams which can penetrate deep into metals (Modern Welding Technology, 1994). Unfortunately to maintain its ability for deep, clean welds, it requires a high vacuum. Such an operation is highly expensive, takes large amounts of energy, and rules out welding large structures as the workspace is confined to the vacuum. Time is also a factor as it takes 12 minutes to pump the vacuum down, and most material that can contain the chamber break easily (Samuel, 2003 and Kren, 2004). It is possible to transmit an electron beam without a vacuum or in a partial vacuum state, however, the electrons unsettlingly disperse and form poor quality welds (Schneider, 2005).

Eventually this ‘conundrum’ of maintaining an electron beam at atmospheric pressure was solved by physicist Ady Hershcovitch of Brookhaven National Laboratory, with his design of the plasma window, (which won an R & D award in 1996.) Quite simply, heated, ionized, plasma acts as a vacuum-shield that deflects atmospheric molecules from interfering with the electron stream. The design also incorporates copper wires that cool down the outer ring of plasma in order to stabilize the inner hot core (Samuel, 2003).Within the plasma the steady flow of electrons generates a magnetic field

which exerts the Lorentz force which has the effect of acting as a lens to focus the beam to as much as 5 centimeters (American Institute of Physics, 2005).

With this innovation electron beam welding has produced “the highest quality welds of any available technique” according to Lawrence Kren, the senior editor of *Machine Design*. Similar to previous vacuum beam welding it produces a high quality weld with a high depth-to-width ratio and low distortion; however the plasma window beam doesn’t require expensive differential chambers (American Institute of Physics, 2005). The ability of not requiring large vacuum equipment undercuts unnecessary costs, according to Acceleron LLC which may save $14,000 in electricity each month. It will also prevent the “12 minutes of ‘dead time’” of pumping down a vacuum which would “increase productivity.” In addition, electron beam welding converts energy more efficiently than laser welding without the “enhancement of the Plasma Arc Window” by “approximately 65 to 75%.”

So what is in store? Since the innovation allows welding at atmospheric pressure the plasma window can be used to weld ships, planes, fighter jets, and when application meets design – specialized aerodynamic cars. Unlike older electron beams, the plasma window beam acts with intense pressure, eliminating vaporization of valuable alloys. The beam is also suitable for scrap recovery and melding different types of metals. This could lead to applications in the construction of microchips and semiconductors (Greenberg, 1996). Also according to the American Institute of Physics at times a filler additive may not be required as it can weld reasonable square butt joints. Also one draw back in the near future that can be easily solved, is that like all electron beams once the beam hits

metal it releases x-ray radiation, which can be prevented from harmful effects with the use of a lead plate (Kren, 2004).

Similar to how it was crafted, all the plasma window needs is a little creativity to find its perfect niche to benefit society. In the future this device can be portable, and can be strapped on to robots both on assembly lines (www.bnl.gov), as well as those that could weld in space. The plasma window can also aid in the construction of giant city towers like Sky City in Japan, or submarines that may reach terrain unseen at the depths of the ocean. There may also be possibilities outside the realm of metal. Similar to lasers it could be used for medical purposes, such as targeted cancer surgery. (Maybe it could be even used as a tool for mining or cutting down trees.)

This product has an exciting magnitude of possibilities, not only does it create “smooth high quality welds” (Samuel, 2003) it also can be used as a tool to aid in the many dreams of the applications of science, from cars that can fly and space stations on other planets to supercomputers that can predict the outcomes of the weather or deep space enigmas. The plasma is waiting for us, are we ready to open the window of its possibility?

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